PRODUCTIVE LAND USE SYSTEMS (PLUS)
Haiti

SOUTH-EAST CONSORTIUM FOR INTERNATIONAL DEVELOPMENT (SECID)
AND
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TECHNICAL SUPPORT TO HAITIAN CACAO

By

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A special acknowledgment is due to M&M/*Mars for its technical and financial support to PLUS and ServiCoop in their efforts to increase participating cacao farmers' productivity and profitability.

Finally, we wish to extend our appreciation to the staff of the Economic Growth Office in USAID/Haiti for its flexibility, financing and timely support of these much needed activities to address critical needs of Haitian cacao farmers.

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FOREWORD

This report is the product of collaboration across a complex series of relationships involving the United States Government, American universities, private voluntary and non-government organizations, a commercial enterprise and farmer organizations. The services of Mr. B.K. Matlick were provided by M&M/*Mars, a chocolate manufacturer and major purchaser of Haitian cacao, to assist Haitian farmers working with the USAID-financed, Productive Land Use Systems (PLUS) Project to increase production and quality of the cacao they produce. Dr. L.H. Purdy and Mr. C.R. Stevenson were employed by the South-East Consortium for International Development (SECID)/Auburn University to follow up on recommendations made by Mr. Matlick.

The purpose of PLUS is to bring about sustainable increases in agricultural production and incomes of hillside farmers through ecologically and economically sound agricultural practices that conserve the fragile environment of Haitian hillsides. Under PLUS, SECID/Auburn University provides marketing and technical support to CARE International and the Pan American Development Foundation (PADF), who in turn provide support and training to farmer organizations. CARE and PADF played a crucial role in providing initial contacts between ServiCoop and farmers, and facilitated the visits of the cacao specialists. SECID provided leadership in the creation of ServiCoop, a marketing cooperative, and provides leadership and oversight.

ServiCoop exports cacao which it purchases from Haitian producer cooperatives or associations. ServiCoop has established a quality control system which assures that the cacao it exports meets the relatively high standards required for importation into the USA and for use by M&M/*Mars. Cacao of this quality has traditionally been exported from the Dominican Republic and is known as Sanchez quality. M&M/*Mars has recognized ServiCoop's commitment to quality by purchasing cacao from ServiCoop at the internationally set price for Sanchez quality cacao rather than at the significantly lower price typically paid for Haitian cacao. ServiCoop is passing this price premium on to farm cooperatives and associations who handle their cacao in a manner that produces the higher quality. M&M/*Mars is supporting and encouraging ServiCoop's efforts by purchasing as much cacao as it can produce, assuming the cacao meets desired quality standards. Working together in this way, M&M/*Mars, ServiCoop, the farm cooperatives, and their farmer members are raising the quality of cacao exported from Haiti. Farmers, their organizations and ServiCoop are reaping rewards in the form of higher incomes. M&M/*Mars is benefitting from the increased supply of its primary raw product assured by this marketing system.

These reports are published as part of the SECID/Auburn PLUS Series because of the valuable information they contain on ways to increase the productivity and quality of cacao produced on Haitian hillsides.

EXECUTIVE SUMMARY

This report is a compilation of four reports by cacao specialists, employed to make recommendations on improving production and quality of the cacao produced by farmers working with the Productive Land Use Systems (PLUS) Project, financed by USAID.

Report by B.K. Matlick, Production and Marketing Specialist - "Cacao Yield Improvement Report"

Findings

- Most cacao plantations in Haiti are unmanaged, resulting in excess shading, which severely depresses cacao yields. A simple program of pruning and stand thinning can give short-term yield increases of 30-50% in the first year following pruning. If 30 % of PLUS cacao farmers make these improvements, this translates to an increase in production of 990 metric tons and economic benefits of $356,400.
- Improved drying is critical to improved quality of cacao beans.
- A disease resembling Witches Broom was observed in the Dame Marie area.
- Rats were identified by farmers as a major pest. They can destroy up to 25% of the crop.
- Failure to invest in tree renewal and improved production was a problem in previous cacao projects.

Recommendations:

- 15-25 demonstration plots should be established to train farmers in proper cultural practices for cacao. Extension specialist Stevenson should determine the number and location of plots.
- A plant pathologist should visit the Dame Marie area to identify the disease and recommend control measures.
- Training in control of rats,
- Training in proper post harvest processing: when and how to harvest, proper fermentation, sun drying and proper storage.
- Purchase of two artificial dryers
- Improvements in sun drying capacity for six farmer cooperative buying stations. This is critical to improve quality.
- Hiring of a full time local Agronomist, who will work on improving yields and cacao quality. He will learn from the consultants and M&M/*Mars and replace the need for the demonstration plot consultant starting in year two and in future years.

Report by L.H. Purdy, Plant Pathologist - "Assessment of the Presence of Witches Broom of Cacao Report"

Findings

- **Witches' broom caused by *Crinipellis perniciosa* is not present in Haiti.** The disease that is present is **FAN GALL**, caused by ***Fusarium decemcellulare***.
- FAN GALL is present in a large area of western Grande Anse.
- FAN GALL has been present in Haiti for more than 15 years and affects a low number of cacao trees. It is unlikely to increase in either frequency or virulence on cacao. FAN GALL is not a serious threat to production.
- Genetic resistance to FAN GALL appears to be present in the cacao population.
- New germplasm is not needed to reduce the frequency of FAN GALL.
- Trees infected with FAN GALL should be removed and burned to prevent further spread.

Recommendations

- **Education:** Farmers should be shown the various symptoms of FAN GALL so that they can determine if tree removal can be adapted to their farms.
- **Quarantine:** If any introductions are considered, protocols must be established for the safe transfer of cacao genetic materials and establishment of a very closely supervised secondary quarantine facility in Haiti.

Report 1 by Christopher Stevenson, Extension Specialist - "Demonstration Plot Selection and Training Curricula, vol. 1"

Findings

- Low yielding and unproductive trees were widespread in Grande Anse and Northern Haiti.
- One or two good producing trees were found in most plots. These can serve as mother trees to furnish bud or vegetative material for grafting onto less productive trees.
- Cacao trees are not properly pruned. Unpruned trees produce mostly suckers, instead of fruit and are tall and difficult to harvest. Pods at the top of the tree may be left unharvested, where they may be infected with black pod, which can spread to other trees, reducing yield.
- Most of the cacao fields had greater than 50% shade, whereas 50 to 75% sunlight is required. This excess shading limits yield.

Recommendations

- Shade should be adjusted to between 35 to 50%.
- Diseased cacao trees should be destroyed.

Accomplishments

Mr. Stevenson identified 11 demonstration plot sites. Preliminary curricula were established for demonstration plot training in upgrading of fields, including tree selection, grafting, pruning and shade adjustment.

Report 2 by Christopher Stevenson, Extension Specialist - "Demonstration Plot Development and Training Curricula, vol. 2"

Findings

- A clone garden for hybrid cacao production is located in Grande Rivière du Nord. Some trees produce 50 to over 100 pods. These trees may serve as source for tree buds. Training would be required to use this garden for seed production.
- Termite damage was observed on old trees at Port Margot.

Recommendations

- Select 5 most productive trees in clone garden for use in grafting and for additional clone gardens.
- Prune top chupons quarterly and lower chupons monthly
- Reduce tree size to 4 to 5 meters after 1 year. This should be followed by 2 to 3 light maintenance prunings a year. If trees remain unproductive, graft.
- When budding/grafting, stake new shoot to support one month after bud release.
- Old tree above the graft may be cut at 90 days from budding provided shade is provided
- Grafting is only as good as the mother tree.
- Prune shade trees that over shade cacao.
- A program for new plantings should include demonstration plots to demonstrate spacing of cacao and shade trees, temporary shade, and management to the producing stage.
- Consultant should return in 90 days to check the demonstration plots and to address any other problems with cacao raised by PADF and CARE staff.

Accomplishments

- Twelve demonstration plots were established.
- Began training farmers, PADF, CARE, and SECID/Auburn agents in improved tree management techniques.
- Created technical sheets (See Appendix II)

Cacao Yield Improvement Project Report

by B.K. Matlick
March 1-5, 1999

I. INTRODUCTION

The objective of this consulting assignment was to assist the marketing cooperative, ServiCoop, and farmers collaborating with ServiCoop and the PLUS project, to increase revenue from the sales of high quality cacao. M&M /*Mars employed the consultant to identify cost effective ways to improve cacao yield and profitability for small farmers in Haiti. He was asked to visit three or more PLUS project-supported cacao production areas in Haiti to meet with cacao farmers and ServiCoop association members to assess local cacao marketing, production, processing and grading techniques. He was also asked to prepare the demonstration design plan.

Mr. Matlick's itinerary is given in Appendix I.

Background

Haiti has historically produced 3000 to 4000 metric tons (MT) of cacao for export. Although there was considerable potential for improvement from existing trees, the relatively low prices paid by local exporters (25-30% of world prices) did not provide an incentive for increased effort from the farmers. An improvement was made in local marketing by the formation of ServiCoop in August 1997. ServiCoop, created by SECID with financial assistance from USAID, together with an export marketing partner, M&M/*Mars, has been responsible for increasing the percentage of the World Cacao Price paid to farmer from 25-35% to 55-60%. This has resulted in increasing the cacao farmer's income by over US$1M in 1998.

II. OBSERVATIONS AND RECOMMENDATIONS

Most cacao trees in Haiti have not been managed for the past 20 years; therefore most trees are over shaded and desperately need to be pruned. Using simple cultural practices, described below, it is expected that short-term yield improvements of 30-50% will be realized. Using demonstration plots for technology transfer in collaboration with local Cacao Cooperatives and the PLUS project, this project is designed to make these cultural practices available to thousands of cacao farmers within the first year. It is expected that 30% of the farmers will receive a minimum of 30% yield improvement the first year. (30% times 3,300MT = 990MT times 30% = 297MT times $1200MT = $356,400). This will result in an additional $356,400 income for cacao farmers participating in the program the first year. It is expected that an additional 30% will participate in the program the second year with similar results.

In addition to demonstrating cultural practices for early yield improvements the program will provide additional benefits through pest and disease management, stand renewal and improved post harvest processing.

Cacao is a tree crop that requires 5-8 years to become profitable. ***A major defect with cacao projects in Haiti in past years has been a failure to invest in tree renewal and improved production***.

Recommendations for pest and disease problems.

- Witches Broom was tentatively identified in the Dame Marie area. If this disease is allowed to go unchecked it has the potential to destroy the entire Haiti cacao crop. In addition, it endangers the Dominican Republic cacao crop of 60,000MT. This should be verified by a qualified plant pathologist. (Ed. note: see Purdy report for correct identification of this disease)
- Rat damage is listed by local farmers as the major pest problem, destroying up to 25% of the crop. I recommend measures be taught to farmers to better control rats.

Recommendations for additional cacao plantings and /or renewal of cacao fields.

- Training in proper post harvest processing. This will include when and how to harvest, proper fermentation, sun drying and proper storage.
- Two artificial dryers are planned, one in Port-au-Prince and one in Dame Marie (Southern Region).
- In addition, improvements for sun drying capacity are planned at six (6) farmer cooperative buying stations. This is critical to improve quality.
- A full time local Agronomist should be hired by ServiCoop to work with Yield Improvement during the growing season, Post Harvest Improvement (Quality) responsibilities during harvest season and assist with logistics duties when needed. This person will learn from the consultants and replace the need for the consultant starting in year two and in future years. He will learn about "Quality Cacao" from the customer, M&M/*Mars, so that ServiCoop can produce and ship the quality of cacao needed by the buyer.

Recommended Implementation Activities

Using the Demonstration Plot (Demplot) system, approximately 15-25 plots will be established starting as soon as the project is approved. The exact number and location will be determined by the implementation team consisting of Chris Stevenson, cacao consultant; ServiCoop field person; CARE/and or PADF representative and the local Haiti Cooperative.

III. BUDGET

BUDGET

Item	Year One	Year Two	
Demonstration Consultant (100 days)	$30,000	$15,000	(50 days)
Per Diem	$ 7,000	$ 3,000	
Plant Pathologist Consultant (10 days)	$ 5,000		
Demplot expenses	$15,000	$ 5,000	
Signs	$ 3,000		
Agronomist (ServiCoop)	$30,000	$30,000	
Dryers (Mechanical and Sun)	$55,000		
Motorbikes (2)	$10,000		
South Buying Center	$60,000	$30,000	
Totals	**$215,000**	**$83,000**	
TOTAL PROJECT OVER TWO YEARS			**$298,000**

Assessment of the Presence of Witches' Broom of Cacao

by L.H. Purdy
March 22-27, 1999

I. INTRODUCTION

The objective of this consulting assignment was to assist the marketing cooperative, ServiCoop, and the farmers collaborating with ServiCoop and the PLUS project, to increase production of high quality cacao by addressing constraints identified by B.K. Matlick, during his recent trip to Haiti.
Specific objectives were to provide the following services, in collaboration with PLUS and ServiCoop representatives and the Cacao Demonstration specialist:

Travel to various sites throughout the PLUS cacao production areas as recommended by project personnel to inspect cacao trees to:

- Confirm the pathogens attacking the trees to determine if witches' broom of cacao is present in the country.
- Determine the extent of the suspected witches' broom outbreak.
- Develop a control program to contain the disease in the immediate and short term future.
- Make recommendations for quarantine education and training of personnel and growers.
- Make other recommendations as deemed necessary to better control diseases in cacao.

Dr. Purdy's itinerary is given in Appendix I.

II. FINDINGS:

- **Witches' broom caused by *Crinipellis perniciosa* is not present in Haiti.** The disease that is present is **FAN GALL**, and the pathogen that causes this disease is ***Fusarium decemcellulare***.
- FAN GALL is distributed uniformly in the area of Dame Marie, south to Anse d'Hainault, east to the summit of the mountains east of Dame Marie, near Chambellan, Mahotiere, Marfranc, but was not present in the area of Burotte and Abricot.
- The management of cacao in the presence of FAN GALL requires that the level of the inoculum of the pathogen that is wind-borne, micro- or macroconidia of *Fusarium decemcellulare*, be reduced or eliminated. To do this requires that diseased trees, that is trees with FAN GALL, be removed and burned. The farmer in Marfranc, who had cut six trees because of FAN GALL, learned of this practice from his father.
- There seems to be genetic diversity in the plantings of cacao in relationship to disease resistance, because the incidence of FAN GALL is quite low, perhaps 1-2% of cacao trees

being diseased. There is no need to introduce new germplasm, genetic materials, as a way to reduce the frequency of FAN GALL. Introductions of new genetic materials might be needed for other reasons.

- ***Threat to cacao production in Haiti*:** FAN GALL of cacao has been present in Haiti for more than 15 years and has apparently affected a low number of cacao trees during its presence in the country. There is no valid reason to believe that this disease will increase in either frequency or virulence on cacao. In fact, the suggested management practice for cacao in the presence of FAN GALL, cut and burn diseased trees, should become an integral part of demonstration plots with the hope that it will become a common farm-level practice in the future. It is untenable to postpone the initiation of the demonstration plots because of the belief that the disease that is present, FAN GALL, constitutes a threat to the cacao industry of Haiti. **FAN GALL is not a threat to production**.

III. RECOMMENDATIONS:

Quarantine and education:

- Farmers should be shown the various symptoms of FAN GALL so that they will be in a position to determine if tree removal can be adapted to their farms.
- If any introductions of germplasm are considered, it is absolutely essential that the protocols established for the safe transfer of cacao genetic materials (Frison and Feliu, 1989) be followed, including the establishment of a very closely supervised secondary quarantine facility in Haiti.

IV. SUMMARY OF ACTIVITIES IN HAITI

Travel began at 7:10 AM on March 22, 1999 followed by arrival at Port au Prince, Haiti around 2:00 PM. Traveled by airplane to Jeremie following meeting with Zach Lea on March 23, then on to Dame Marie. March 24 and 25 viewing cacao farms in the company of Chris Stevenson (Cacao Consultant) and Gary Jerome (CARE Officer), and Robert Bulten (CARE Director, Jeremie). March 26 returned to Port au Prince and met with Zach Lea (SECID) and later with Mike Banister (PADF). Talked via telephone with Felipe Manteiga (USAID). March 27 returned to Gainesville.

Field Notes:

Dame Marie and vicinity

Farm across road from cacao co-op. Saw cushion gall (CG) many with broom-like growths from flower cushions, some with branch lengths up to 6 inches. One broom had 8 branches that were organized in a fan-like arrangement. There were no vegetative brooms from terminals or leaf axils.

Collected broom-like structure and placed two cross-sections on two water agar slants. Also, photographed the broom.

The tree in the backyard of the CARE Office had CG and distorted growth from many flower cushions that were similar in appearance to very small witches' brooms. It was apparent that the broom structures developed only from flower cushions, with central stems of the brooms distorted at their bases at the points of emergence from the flower cushion from which they developed. This central stem was enlarged with nodes close together, and branching that resulted in the formation of a fan-like broom with abundant buds on the developing branch adjacent to the central axis of the broom. Several of the branches of the broom-like structure continued to grow, and as growth continued the branch, or shoot, seems to "grow through" the distorted growth portion of the broom on which the internodes were relatively long as if the stem was normal, and apparently not affected by the malady. There were no vegetative brooms present on any of the trees observed.

Anse d'Hainault

Traveled south to the town, met the owner of the cacao co-op, Cupa, who led us to three plantings of cacao, and a nursery. Saw cacao trees with CG and broom-like growth from flower cushions. The nursery contained many black plastic bags of the type used for producing cacao seedlings that still contained soil, but without seedlings. There was no shade present, and there was no evidence that any shade had ever been provided. An estimate suggested that about half the number of plastic bags initially in the nursery still were present. At another cacao planting a seedling was found that had a terminal broom somewhat similar to the type that develop following inoculation of seedlings with the witches' broom pathogen. At another farm one additional seedling with a terminal WB-like broom was found.

We returned to the vicinity of Dame Marie where six farms were visited: (1) one tree with CG in about 200 trees; (2) no CG in about 200 trees; (3) one tree with CG in about 100 trees; (4) three trees with CG and small broom-like structures; (5) three trees with CG in about 20 trees; (6) two trees with CG in about 75 trees, and three seedlings with terminal broom-like structures. Made isolations from one dark broom, presumably still living, and one green broom from the brooms on the seedlings.

Dame Marie to Jeremie to Abricot

From Dame Marie to Abricot, 20 farms were visited. (distances are from last stop)
About 0.25 km found what appeared to be two axillary brooms and CG.
0.25 km, one tree with CG and cushion brooms.
0.25 km, CG, brooms.
0.25 km, CG, brooms, and mistletoe.
Across road from Ecole de Montagnac, CG and brooms, near summit.

Over summit, no CG, no brooms.
0.5 km, no CG.
0.1 km, no CG.
0.25 km, no CG
0.25 km, CG and brooms in one tree.
0.25 km, no CG, one axillary broom on volunteer seedling.
Chambellan, no CG, no brooms.
0.4 km, no CG, no brooms.
1+ km, two trees with CG, brooms.
2 km, CG and brooms.
Mahotiere, CG, two trees with brooms.
Moron, no CG, no brooms.
Marfranc, severe CG, severe brooms. Farmer saw diseases in 1981-82. Had cut and burned six trees because of the disease problem sometime in the past. Shoots, or branches of the brooms, that continued to grow appear to be developing normally, that is with internodes that are similar in length to the non-affected or healthy shoots or branches.
Anse du Clerc, Burotte, no CG, no brooms.
Abricot, no CG, no brooms.
Returned to Jeremie as daylight vanished.

I brought eight small water agar slants with cross-sections of small branches from brooms to Gainesville for microscopic observation in the laboratory of E.R. Dickstein/J. Jones (permit no. 39181) in the Plant Pathology Department, University of Florida, Gainesville, Florida. Observation should reveal that the pathogen associated with brooms from flower cushions of cacao is *Fusarium decemcellulare* (*rigidiuscula*).

V. CONSIDERATIONS TO THIS POINT

Based on the fact that all but six brooms observed on many trees of cacao originated from flower cushions, it was deemed probable that the brooms that developed were not induced by *Crinipellis perniciosa*, the witches' broom pathogen, but by the cushion gall pathogen, *Fusarium decemcellulare*. Four of the six brooms that developed at the terminal bud of volunteer seedlings, and the other two were in leaf axil buds, both locations of cacao have been reported to have produced such growth as a result of cushion gall (Thomas, 1973). Cushion gall seems to be a disease, or group of similar diseases, that occurs in Central and South America, and other locations including the Dominican Republic. To my knowledge there have been no previous reports of cushion gall in Haiti. Cushion gall diseases are not industry threatening, and cause only minor losses because cushions with galls usually stop producing flowers.

We observed what we believed to be microconidia of *Fusarium decemcellulare* present in fungal growth from FAN GALL tissues that had been placed on water agar slants. In addition, mycelial characteristics suggested *Fusarium* spp., but we did not observe macroconidia of *F. decemellulare*. None of the fungal hyphae that developed from the tissue pieces resembled basidiomycete fungus, that is, clamp connections were not observed. The pathogen causing witches' broom, *Crinipellis perniciosa*, produces clamp connections, and thus was not the causal agent of the brooms observed.

In Haiti there appeared to be at least four different phenotypes/genotypes of cacao trees that may be distinguished by small green pods, long green pods, light red pods, and dark red pods. According to a field technician with CARE, cacao seed imports into Haiti have not occurred for at least 40 years. It is certainly possible, and highly probable that there are additional genotypes of cacao in Haiti, but all of the individuals we met knew nothing of the source of planting materials, or of the clones that had been planted. Regardless, the observed diversity in cacao plantings seemed a plus factor, because only a few trees were apparently susceptible to cushion gall, but whether or not they were the same clone cannot be determined.

There are several types of cushion gall described in the literature, and the cushion gall observed in Haiti fits the description of "Fan Gall", as discussed by Hutchins and Siller (1960), and Thomas (1973). Wood and Lass (1985) assign cushion gall diseases as being of little economic importance, perhaps because of the low incidence of diseased trees. On the other hand Wood and Lass cite Siller, who reported losses of about 50% in Costa Rica at one location as a result of cushion gall disease.

Applications of fungicidal chemicals are not recommended because, according to Wood and Lass (1985), the life cycles of the pathogens are not known adequately. Under present day conditions, the cost of fungicides would be prohibitive and detract significantly from their potential use.

Where the incidence of CG is low, the diseased cacao trees should be removed (Hardy, 1960). This practice should be used in Haiti to manage cacao in the presence of the cushion gall disease, Fan Gall. Removal of six trees by one grower who observed the disease in trees on his farm, points clearly to the fact that growers who receive technical assistance relative to the identification of Fan Gall, could apply this very effective method of disease control.

If there is consideration for the introduction of new cacao germplasm into Haiti, a secondary quarantine should be established to reduce the possibility of the introduction of biological agent not now present in the country. But new germplasm of cacao that is untested in Haiti is not needed at this time. There are productive and CG-resistant trees of cacao in almost all plantings that were observed. Vegetative propagation of this germplasm in demonstration plots should become a reality as soon as possible, and farmers should be instructed how to propagate cacao by grafting or budding existing healthy but nonproductive trees.

VI. CONCLUSIONS

The problem has been identified as Fan Gall, a flower cushion gall disease. Management of Fan Gall must seek to attain a reduction in disease incidence, because complete control might be neither realistic nor possible. Proper management requires that diseased trees be identified. Once identified, a plan to eliminate them should be established, that may require individual management methods for each farmer because all farms do not contain an equal number of diseased trees. Rehabilitation of cacao farms will require new planting materials derived from local selections for use by growers who remove trees. The cost of such new replacement trees should be low, or subsidized in some manner so that growers will be inclined to participate in the tree replacement program.

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Demonstration Plot Selection and Training Curricula with Outline of Material for Adaptation by PLUS Project Personnel - Report 1

By Christopher R. Stevenson
March 22-April 3, 1999

I. INTRODUCTION

The objective of this consulting assignment was to assist the marketing cooperative, ServiCoop, the farmers collaborating with ServiCoop and the PLUS project, to increase production of high quality cacao by addressing constraints identified by B.K. Matlick, during his recent trip to Haiti. The specific assignment was to provide the following services, in collaboration with the Plant Pathologist and PLUS and ServiCoop representatives:

- Travel to various sites throughout the PLUS cacoa production areas as recommended by project and ServiCoop personnel to provide the required marketing assistance.
- Assist the plant pathologist with the development of a disease control program.
- Select 15 to 25 demonstration plots in the northern and southern cacao producing areas of the PLUS project.
- Selection to be based on representative farms of cooperating farmers to demonstrate improved practices, emphasizing pruning, shade adjustment and tree upgrading to maximize cacao production.
- Develop training curricula for the demonstration plots and outline the development of training material for adaptation by the PLUS project personnel. The final material will be translated into Haitian Creole for distribution by the PLUS project and will be shared with others working in hillside cacao production.

The itinerary for the visit is given in Appendix I.

II. OBSERVATIONS and RECOMMENDATIONS

Condition of cacao fields in the south and the north.

We first saw the disease problem in the South. The trees affected appear to produce brooms that render the trees unproductive, but the brooms are produced only from the flower cushions. Unlike witches' room only a few trees are infected and not the whole field. Other witches' broom symptoms are absent. The best way to deal with these few trees is to destroy them and indeed one farmer has been doing just that over the past 15 years or so, and he has found only 6 trees in that time. The destruction of these trees should not be a problem as they are not productive.

In the south, five plots were chosen - one each at Dame-Marie, Chambellan, Moron, Marfranc and Abricot. The trees on these plots are over grown and too high. Some have more then one trunk. Most of the fields are over shaded. Shade trees used here are mainly bread fruit or other fruit trees. These trees are high and too closely spaced, causing dense shade. Limestone soils with possible high pH seem to be common in this part of Haiti. Some limestone induced iron deficiencies were seen in the field.

Traveling in the northern part of the country with PADF agents, we selected sites at Grande Rivière Du Nord, Mazé, Bahon, Margot, L'ACul Du Nord, and La Plange. Here the cacao trees and shade situation is similar to that in the south, though some plots may have open areas that can be replanted. Two or three plots still need to be chosen as we could not reach a favorable area for site selection due to a flooded river.

In both areas, we found low and non producing trees. At the same time most plots do have a good producing tree or two. These better producing trees can be used to provide bud wood for the farmer to bud or graft the non or low producing trees. This will be part of the program to upgrade the fields along with pruning and shade adjustment. The logic is that 30% of the trees in most fields produce 70% of the crop. Thus by using the better trees as mother trees to furnish bud or vegetative material, we can upgrade the field by grafting the less productive trees.

In general the cacao trees have not been properly pruned. Instead of letting the trees produce a *jorquette* (the point where the tree starts to produce side or "fan" branches), they have let the tree produce a sucker to continue upward growth. Trees that are too tall are difficult to harvest and often pods are left in the tops of trees. These may be infected with black pod and their spores will be a source of infection to the other trees. Also trees that are allowed to produce suckers use most of their energy to produce growth and less to produce fruit.

Cacao trees require 25 to 50% shade, i.e., 50 to 75% sun light. Most of the cacao fields were greater than 50% shade. This over shading has limited yield by cutting down on the solar radiation which is needed for production of cacao pods. Shade of 35 to 50% should give sustainable yields where as closer to the 25% shade will require additional inputs of fertilizer to maintain yields. Little or no shade will give rise to high yields which are difficult to maintain over time and need large inputs of fertilizer. Too much sun light also presents other problems such as increased insect infestations, die back and contributes to shorter lives of the cacao trees.

Recommendations

It is recommended to ***adjust the shade to between 35 to 50% shade,*** either by eliminating or pruning existing shade trees. The best way to deal with diseased cacao trees is to destroy them.

III. TRAINING CURRICULA FOR THE DEMONSTRATION PLOTS AND THE DEVELOPMENT OF TRAINING MATERIAL FOR ADAPTION:

Following is a list of training activities to be covered with the demonstration plots.

A. Demonstration Plots Curricula

1. Determine Needs to Upgrade Fields
   a. Show cacao with management problems.

   b. Show cacao with desirable and non-desirable characteristics.

   c. Discuss strategies to increase production.

2. Reworking Trees for Increase Production
   a. Select promising trees.

   b. Select low or non producing trees.

   c. Show how to manage them for bud production.

   d. Discuss grafting methods used to upgrade established trees.

   e. Demonstrate the grafting techniques:
      1) Selection and preparation of buds.
      2) Selection and preparation of sucker to be grafted [budded].

3. Budding and wrapping the bud with tape.

4. Patch bud trunk and side grafting.

5. Post management of budded and grafted trees.

6. Activities: Upgrading low producers
   a. Selection of high yielding trees.
      1) At or just before main harvest season, select highest producing trees on each plot or farmers field.
      2) Record the pod number in a note book with location and mark tree with flagging tape or paint.
      3) If need be select trees on neighbor farms when no superior producing trees are found on plot.

b. Selection of lowest producing trees on demonstration plot.
   1) Mark trees (paint or tape).
   2) Determine grafting methods - on trunk or suckers.
   3) Training and practice in grafting
   4) Thin out canopy and prune mature tree, staking of young tree.
   5) Training of young grafted tree to production stage.

c. The Cooperative clone garden selection
   1) Count pods and mark productive trees (over 30 pods), giving each a number and keeping data in a note book on number of pods produced.
   2) The best from this garden can supply coop members with very productive material.

B. Pruning.

1. Discuss pruning.
   a. Tree form.

   b. Reasons for pruning.

   c. Sanitation pruning.

   d. Maintenance pruning

2. Demonstrate - elimination of suckers on the trunk and principal branches.

3. Demonstrate - pruning of over extended and inferior branches.

4. Demonstrate - the elimination of branches that are dead, infected or broken.

5. Demonstrate - Large cuts with machete and saw.

6. Demonstrate - Lowering the height of the tree.

7. Assign a tree to each participant to prune and then evaluate.

8. Activities : Pruning low producers:
   a. non productive trees prune first (bring down).

   b. non productive trees prune to one stem and eliminate old suckers.

c. maintenance pruning.

Note: Prune other trees between harvest seasons when there are few pods being formed and flowering is at a minimum.

D. Shade Adjustment.

1. Discuss reasons for shade and the management strategy.

2. Discuss relation of shade to nutrients and growth.

3. Discuss the elimination of shade trees by: ringing or poisoning.

4. Discuss ways to judge shade.

5. Demonstrate - methods of elimination of excess trees or pruning.

6. Activities. Shade adjustment: Reduce number of shade trees or prune shade trees.

IV. FUTURE ACTIVITIES TO BE PERFORMED

It is recommended that another four week assignment be planned for the May-June time period to establish the demonstration plots after the harvest to better training farmers for the upcoming production season. During this assignment, the following actions should be undertaken, as well.

A. Other Issues to be Addressed

1. Insects, Disease, Weeds, Rats

2. Missing Trees-replant open areas with new seedlings. Open canopy to let in light. Discuss.

3. Fertilizing, Soil Tests
   Take a composite soil test from each plot.
   Determine where to get soil analyses done in Haiti.
   Discuss how to and why. Determine status and requirements.
   Discuss shade and fertilizer inter-relationship.

4. Harvesting and Drying

B. Develop Protocols during May/June Field Trip for :

1. Demonstration site selection
, easily accessible.
, 100 - 200 trees.
, near other cacao farmers.
, an interested farmer.
, farmer must know and agree to what needs to be done.

2. Upgrading cacao fields
, superior tree selection.
, techniques used.
, after training to maturity.

3. Pruning
, lowering height.
, reshaping.
, maintenance.

4. Shade
, the use of shade.
, pruning or elimination methods.

5. Soil Sampling
, sampling method.
, preparation.

6. Nursery for replacement trees
, appropriate size.
, material.
, management.
, hybrid or budded seedlings.

7. Planting field with seedlings.
, open areas.
, new field.
, leguminous trees as temporary shade.
, food crop temporary shade.
, permanent shade.

Demonstration Plot Development and Training Curricula with Outline of Material for Adaptation by PLUS Project Personnel - Report 2

By Christopher R. Stevenson
May 23 - June 19, 1999

I. INTRODUCTION

Purpose of Visit

The author was requested to:

1. travel to various sites throughout the PLUS cacao production areas as recommended by project personnel to provide technical assistance
2. Develop 15 to 25 demonstration plots in both the northern and southern cacao producing areas of the PLUS project emphasizing primarily pruning and shade adjustment to maximize cacao production.
3 Finalize training curricula for the demonstration plots and outline the development of training material for adaption by the PLUS project personnel.

Accomplishments Relative to the Purpose of Visit

- Provided technical assistance required by project personnel in the PLUS cacao production areas.
- Developed 12 demonstration plots: seven in the northern and five in the southern producing areas. Three plots were not done in the north because one farmer could not agree with PADF personnel and due to time restrictions in Dondon. Also another plot needs to be selected.
- Produced training material in the form of "sheets" to be translated into Creole.
- Developed recommendations for continuation of project.

The itinerary of the author is provided in Appendix I.

II. CONSIDERATIONS

<u>Clone Garden</u>

At the cooperative clone cacao garden[1], Grande Riviére du Nord, we saw the clone markers (in cement). The garden was set up to produce hybrid seed - the flowers from one row to pollinate

[1]The clone garden was installed in 1983 by Lepido Batista, of the Dominican Republic under contract from the Mennonnite Economic Development Association (MEDA). PADF currently provides support to the clone garden.

the flowers of the second row. Some retraining in hand pollination, seed preparation and seed garden management may be needed if this is the route they wish to follow. PADF personnel have taken some data on apparent high producers in this garden. They have found some cacao trees that produce 50 to over 100 pods. I recommended that they select the 5 top producers for tree budding in the field.

Demonstration Plots

All plots (Grande Riviére du Nord, Bahon #1 & #2, l'Acul du Nord, Port Margot #1 & #2, and Dondon #1 in the north and Anse d'Hainault, Dame-Marie, Moron, Marfranc, and Abricot in the South) were pruned and bud grafting practice was done. Superior trees were selected on most plots by farmers (except Grande Riviére du Nord which used buds from the clone garden). Two plots were not done in the North due to one cancellation and the other in Dondon due to lack of time and inclement weather. Two other plots need to be selected.

A. Pruning

The pruning concentrated on chupons[2], especially old chupons and top growth. The aim was to (1) lower tree height and stop upward growth, (2) encourage growth to the side, and (3) to encourage production on the lower part of the tree.

B. Mature bud grafting

Training of grafters to patch bud mature and young trees was presented to those who already have experience with grafting on other trees, (mango and citrus). The results of the grafting will have to be checked at bud release. Most will probably need to be rebudded as it takes practice to become efficient. This is why grafting three buds to each tree was recommended. The experienced grafters and most of the PADF/Coop "technicians" learned the process.

C. Shade

Most shade trees found are fruit trees. Although most do not produce excessive shade their close spacing presents some problems. One fruit tree - the mango - produces the most problems with excessive shade. They should be pruned or not planted in association with cacao in the first place. As fruit trees are a source of income their removal can not be recommended. Some pruning should be attempted especially if these trees are closer than 10 meters. Some shade trees were pruned in the north and on most plots in the south. The pruning of shade trees was easily done and was not time consuming.

[2]Shoots or suckers that develops on the stem. Left alone, they turn into additional trunks that produce much wood with little fruit production.

D. Other problems

On the second plot at Port Margot a few of the old trees had termite damage. This problem should be watched.

III. RECOMMENDATIONS

A. The COOPERATIVE clone garden selection

, Count pods. Mark the 5 selected productive trees, giving each a number and keeping data in a note book on number of pods produced. They should have an origin reference such as "selection A (# 7)" or other.

- The best 5 from this garden can supply coop members with very productive material.

- If other coop/producer associations are interested they could buy budded seedings or bud wood from the clone garden. Each association could get ten trees of each selection (50 trees) for their own clonal garden. Thus they would be able to furnish their members with bud wood.

B. Pruning

- As follow up, the plots should be checked every three months to see if there are any top chupons. If so, prune these but not any other top growth as we want to fill the canopy with leaves.

- Every month prune bottom and lower chupon growth.

- After one year, look for opportunities to bring trees down to 4 to 5 meters. The elimination of multiple trunks and renewal of the trees can be considered. When the 4 to 5 meter level is reached, only 2 to 3 light prunings a year for maintenance is all that is needed. If, after 6 months to a year, trees appear to be non-productive, then replacing them by grafting should be considered.

C. Budding/Grafting

- A month after bud release, the new shoot should be staked for support.

- In Costa Rica, they recommend cutting the old tree above the graft at 90 days from budding. They get production in 16 months. If this is followed, be sure there is shade for the new tree.

- A point to remember is that grafting is only as good as the mother tree. There is no reason to graft if there is not an improved choice of material.

D. Shade

- Look for opportunities to prune shade trees that over shade cacao.

E. New Plantings

- Interest has been shown in making new plantings. A program for this should include demonstration plots starting with cleared fields. Farmers would receive seed and/or grafted plants plus technical guidance if they follow the program demonstrated on the plots. These plots would demonstrate spacing of cacao and shade trees, temporary shade, and management to the producing stage.

F. Follow up

- It has been suggested that I return in 90 days to check the demonstration plots. Also, it would be an opportunity to address other problems with cacao if the staff of PADF and CARE believe it necessary.

G. NOTES on YIELD

Notes on Yield
35 leaves more or less to produce 1 pod
Kg dry beans per area = number of trees per area X number of pods harvested per tree X number of beans per pod X beans weight.
Pod index = number of pods / Kg dry beans.
Bean index = number of dry beans / 100 grams.
Yield increases
Shade thinning ... immediate effect pruning ... effect in 6 month to 2 years grafting ... 1.5 to 3 years , best longtime effect
Harvest frequently. Once a week if possible. This may help decrease losses due to rats and disease.

H. Things to avoid

- Do not pull, twist off or otherwise damage the flower cushions. These damaged cushions often will not produce flowers thus no pods. Thus harvest cacao pods by cutting pods.
- Do not cut the tree unnecessarily.
- When pruning avoid tearing the bark.
- Do not dry cacao on metal. This will produce black beans.

IV. DEMONSTRATION PLOTS CURRICULA

A. Determine what needs to be done to upgrade field

1. Show cacao with management problems.
2. Show cacao with desirable and undesirable characteristics.

3. Discuss strategies to increase production.

B. Reworking Trees to Increase Production

1. Select promising trees.

   a. At, or just before main harvest season, select highest producing trees on each plot or farmers field.

   b. Record the pod number in a note book with location and mark tree with flagging tape or paint.

   c. If need be select trees on neighbor farms when no superior trees are found on plot.

2. Select lowest producers on demonstration plot.

   a. Mark trees (paint or tape).

   b. Grafting methods - on trunk or suckers.

   c. Training and practice of farmer and extensionist.

   d. After training of grafts.

      1) Thin out canopy and pruning of mature tree, staking of young tree.

      2) Training young grafted tree to production stage.

      3) Or Costa Rica method. Cut old tree above graft at 90 days.

C. Pruning

1. Discuss pruning.
   a. Tree form.
   b. Reasons for pruning.
   c. Sanitation pruning.
   d. maintenance pruning

2. Demonstrate - elimination of suckers, on the trunk and principal branches.

3. Demonstrate - pruning of over-extended and inferior branches.

4. Demonstrate - the elimination of branches that are dead, infected or broken.

5. Demonstrate - Large cuts with machete and saw.

6. Demonstrate - Lowering the height of the tree.

7. Assign a tree to each participant to prune and then evaluate.

D. Shade Adjustment

1. Discuss reasons for shade and the management strategy.

2. Discuss relationship of shade to nutrients and growth.

3. Discuss the elimination of shade trees by ringing or poisoning.

VI. TECHNICAL SHEETS

Technical Sheets are given in Appendix II

APPENDIX I

A. Itinerary of B.K. Matlick

March 1, 1999 Fly to Port au Prince
March 2, 1999 Fly to Cap Haitien
March 3, 1999 Fly to Jeremie and drive to Dame Marie
March 4, 1999 Return to Port-au-Prince
March 5, 1999 Fly to USA

B. Itinerary of L.H. Purdy

March 22 Fly to Port-au-Prince
March 23 Flew to Jeremie and then on to Dame Marie by road.
March 24 Visited cacao farms in Dame Marie and Anse d'Hainault.
March 25 Visited cacao farms in Chambellan, Moron, Marfranc and Abricot.
Returned to Jeremie
March 26 Flew back to Port au Prince
March 27 Flew back to USA

C. Itinerary of C.R. Stevenson, Trip 1

March 22 Fly to Port-au-Prince
March 23 Flew to Jeremie and then on to Dame Marie by road.
March 24 Visited cacao farms in Dame Marie and Anse d'Hainault.
March 25 Visited cacao farms in Chambellan, Moron, Marfranc and Abricot.
Returned to Jeremie
March 26 Flew back to Port au Prince
March 27 Port-au-Prince
March 29 Port au Prince and flew to Cap Haitien.
March 30 Cap Haitien: Visited farms in Grande Riviere du Nord, Maze and Bahon.
March 31 Visited farms in the Port Margot region.
April 1 Visited farms in L'Acul du Nord and La Plange. Flew back to Port au Prince.
April 2 Port au Prince
April 3 Flew back to U.S.A.

D. Itinerary of C.R. Stevenson, Trip 2

May 23 Traveled from Gainesville, Florida to Port-au-Prince, Haiti.May 24. Traveled from Port-au-Prince to Cap Haitien. Met with PADF people A.M. P.M. went to Grande Rivière. Met with Coop. people, looked at clonal garden. Met farmer of demo-plot. Late P.M. returned to Cap Haitien.

May 25	Returned to Grande Rivière du Nord. Gave instruction on pruning. Pruning of plot begins. Late P.M. returned to Cap Haitien.
May 26	Returned to Grand Rivière du Nord. Finished pruning and trained grafters to bud cacao both on chupons and mature trees. Late P.M. returned to Cap Haitien.
May 27	Traveled to Bahon and met with farmer representatives and gave instruction on pruning. Pruning of plot begins. Late P.M. returned to Cap Haitien.
May 28	Finished pruning and trained grafters to bud cacao both on chupons and mature trees. Pruners start and finish second plot at Bahon. Grafters bud trees at second plot. Late P.M. returned to Cap Haitien.
May 29	Worked on notes for next visits and for final report in Cap Haitien.
May 30	Sunday Cap Haitien
May 31	Traveled to l'Acul-du-Nord, met with farmer and gave instructions on pruning. Pruning of plot begins. Late P.M. returned to Cap Haitien.
June 1	Traveled A.M. to l'Acul-du-Nord. Pruning finishes P.M. Trained grafters in P.M. to bud cacao both on chupons and mature trees. Late P.M. to Cap Haitien.
June 2	A.M. traveled to Port Margot. Plot #1 farmer selected several good trees, met with farmer and gave instruction on pruning. Trained grafters in P.M. to bud cacao both on chupons and mature trees. Late P.M. to Cap Haitien.
June 3	A.M. traveled to Port Margot. Plot #2 Pruning conducted and budders practiced mature tree budding. P.M. to Cap Haitien.
June 4	A.M. Traveled to Dondon. Gave instruction on pruning. Trained grafters to bud cacao. P.M. to Cap Haitien.
June 5	A.M. traveled to Port au Prince. P.M. worked on notes for report.
June 6	Sunday, Port-au-Prince
June 7	A.M. traveled to Jeremie. P.M. traveled to Moron by road.Visited first plot and selected superior trees for bud material.
June 8	A.M. Started pruning training. Started grafting and continued pruning rest of day.
June 9	A.M. Started pruning training in Marfan. Five trees selected. Some shade trees pruned.
June 10	Budding A.M. 6 trees done of 20 (3 rows) tree block. P.M. departure for Dame-Marie.
June 11	Dame-Marie plot #1 started pruning.
June 12	Finished pruning plot. Grafting started but not enough bud wood available. A lot of shade trees pruned.
June 13	Anse d'Haiault plot started. Punning of cacao and shade trees started.
June 14	Anse d'Haiault plot finished. Budding started with CARE grafters. Bud wood also collected to work on Dame Marie plot. Returned to Jeremie P.M.
June 15	Traveled to Bon-Bon/Abricot. Started pruning Abricot plot.
June 16	Finished pruning cacao and shade trees. Trained grafters. P.M. returned to Jeremie.
June 17	Debriefing at CARE office.
June 18	Traveled to Port-au-Prince. SECID debriefing.
June 19	Return to Gainesville, Florida.

APPENDIX II

TECHNICAL SHEETS

PRUNING TECHNICAL SHEET

A. Limiting tree height:

The leaf canopy should be about 4 to 5 feet thick (1.2-1.5 m) with a maximum height of 15 feet (4.5 m)[1]. In lowering tree height, cut upright branches on the top of the tree to one-half their height. Repeat a year later or for several years on an annual basis until height has been brought down to 4 to 5 meters.

Another system would be to bring the trees down in one cutting. For demonstration purposes we will do this pruning at one time on non-producing cacao trees.

After bringing the trees down, one should prune lightly two or three times a year. The aim will be to (a) maintain height, (b) trim branches that are turning down into the middle of the row, (c) dead branches, (d) crossing branches in the middle of the tree, and (e) suckers.

B. Timing

- End of dry season and before main flush.
- End of main harvest.
- Before main pod setting period and not during main pod developing phase. Try to balance these though all may not be possible.
- Not during flushing periods. The leaves on pruned branches should be mature[2].

C. Sucker Pruning

- At harvest, prune suckers. If there is no harvest for a month, then do a sucker pruning cycle.
- Prune suckers from trunk and main branches.

D. Sanitation pruning

At the end of the main harvest, prune out dead branches, epiphytes, climbing plants, old diseased and overripe pods.

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[1] Lopez, A., 1985. Pruning - Recommended Plantation Policy, In-House Paper.

[2] Dominquez, M.A., Pruning, 1984. International Training on Technique in Cacao Production in Belize.

E. Technique:

1. Around the base of every branch is a swelling known as a collar. Within it is the protective zone of the branch, that is, the place where the branch's chemical defenses are established. The collar should not be injured or removed by pruning[3]

2. Cuts should be made in such a way that rain can run off easily[4].

3. All tools should be sharp. They generally consist of pruning knives, cutlasses, saws, hand pruners, and lopping shears.

[3] Shigo, A.L., Compartmentalization of Decay in Trees, 1985, Scientific American, pp. 96-103.

[4] Dominquez, M.A., Pruning, 1984, International Training on Technique in Cacao Production in Belize.

MATURE BUDDING PROGRAM TECHNICAL SHEET

A. Introduction

1. In a typical cacao field, 30% of trees produce 70% of the production.

2. Trees are not uniform.

3. Need to first determine reason for low yields; i.e. drainage, over-shading, fertility, etc.

B. Program

1. Select low or non-producing trees.

    a. Mark trees (differently from superior trees).

2. Replacement strategies

    a. Bud very low producers first.

    b. Check medium level producers second year to see if there is improvement and mark again. Then decide if to bud.

3. Budding methods

    a. Closed Method (on trunk)

    A horizontal cut of about 6-8 mm is made into the trunk to cambium depth. Two parallel vertical cuts 3-4 cm long are made upward from the ends of the horizontal line.

    The bark is then carefully peeled upward to expose a panel of cambium, 6-8mm wide and 3-4 cm long for receiving the bud patch.

    A bud patch narrower than the fresh exposed stock panel is placed against it. The bud on the patch should be situated above the petiole remnant that is against it.

    Strict cleanliness should be practiced to avoid any possible contamination with soil or other matter on the cambial surfaces.

    Once the bud patch is placed against the freshly exposed stock panel, it is closed up by reinstating the bark flap to its original position with the help of the budding tape.

In this method it is important to ensure that the petiole remnant is taller than the bud when reinstating the bark flap.

The bud patch is positioned firmly against the stock panel by means of budding tape (2.5 cm wide).

Binding starts below the panel and the tape is wound clockwise and upwards; each turn overlaps the preceding one to ensure satisfactory seal.

Timing of budding tape removal = 10 -15 days.

Budwood taken from softwood budsticks. In our case, use chupon buds (orthotropic) if possible as these will produce a normal tree.

C. Tips

- Use masking tape above the graft as additional protection against water infiltration.
- Make 3 buddings on the same tree to insure success.
- After bud release (when the bud begins to open), make a 5 cm cut on the trunk, 2 cm above the bud and 1/2 cm wide. This is to stimulate growth of the bud.
- A month after budding stake the new shoot.
- Two months after budding - prune the tree above the bud graft.
- At three months eliminate the tree to just above of the bud graft.

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References

Mohd. Jelani Bahaudin A. Raaub Maulud & Aleham Hambali-
Evaluation of several mature budding techniques of cacao.
Proceedings International Conference on cacao & Coconuts.
pp.147-156, Kuala Lumpur, 15 - 17 Oct. 1984.

Helfenberger, Andre - La Aplicacion de alta tecnologia en
cacao por el sector privado en Filipinas y Costa Rica.1991.

BUDDING BASAL CHUPONS (Patch Budding) TECHNICAL SHEET

In the chupon to be budded, make a 3-4 mm horizontal cut to cambium depth. Make two parallel vertical cuts 3-4 cm long. Peel carefully down to expose a panel of cambium 3-4 mm wide and 3-4 cm long. Trim the flap to 1 cm length to provide a tongue to help hold the budpatch in place.

A budpatch narrower than the exposed stock panel and with a centrally located bud about 2 cm from its lower extremity is removed carefully from a budstick.

The budpatch is placed at once against the exposed panel. Cambial surfaces must not be handled or subjected to lateral or vertical pressures.

With the budpatch positioned, its upper extremity is then trimmed to ensure it fits snugly into the stock panel and the remnant of the leaf petiole is pruned back almost flush with the bark surface. Binding starts below the tongue and the tape is wound clockwise and upwards, each turn overlapping the preceding one to ensure satisfactory seal.

In patch budding, a maximum of one third of the circumference of the rootstock bark is cut open.

In patch budding, a 1 mm space between the sides of the budpatch and the "window" of the rootstock will allow callus growth.

The budding tape is released 14 days after budding.

After the tape release, the stocks are topped to allow 4 to 8 leaves be left above the patch. A maximum of 6 inches (15cm) of stock remain above the budpatch.

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References

Hewitt, J.P.A.- Budding Cacao for Redevelopment.
Lowlands Agricultural Experiment Station, Keravat.

Shepherd, R., C.F. Chong & J.G. Taylor- Experiences
with Nursery Budgrafting on Cacao Estates in Malaysia.

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TREE SELECTION TECHNICAL SHEET

1. Choose trees with 30 or more pods during one harvest season.

2. Mark trees and note tree location.

3. Data is to be taken over time and should be kept on file.

    a. Number of pods to produce 1 kilo of dry beans.

        - Weigh wet beans from a number of pods from selected tree and multiply by 38% to get estimated dry weight. (100 lb wet beans yield 38 lb dry beans at 7 % moisture).

        - Calculate number of pods to equal 1 kilo dry weight.

        - This is the pod index.

    b. By counting, determine the number of beans per pod (average) for the selected tree.

    c. Number of pods harvested by month will be noted.

4. Trees chosen can be from the demo-plot, outside the plot, or from other farms.

5. Good producing trees will be used as mother trees for mature tree budding.

Trees with few or no pods will be considered unproductive. They will be marked for grafting and major pruning.